

Evidence Based Tooth Whitening

Dr. Bruce A. Matis

www.bamatis.com

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The objective of this presentation is to increase your understanding of tooth whitening. We will do this by reviewing mostly clinical studies in the scientific literature that have been published. The presentation has been divided into eight sections. They are:

Introduction

Material Concerns

Tooth concerns

Pulpal concerns

Effectiveness of Systems

Cases

Introduction

-Why learn about tooth whitening?

--Restorative Dentistry is changing. "The more we cut tooth, the more we weaken tooth."

-How do we present it to our patients without insulting them?

--To promote bleaching have posters, offer staff bleach or discuss color at treatment planning appointment. Ask "How do you like your smile?" or "Are you pleased with the color of your teeth".

--Beware of patients with unrealistic expectations because they are seldom satisfied.

-How do you know if someone has already bleached?

--Check cuspids, if as light as centrals and laterals, patient has probably already bleached.

-How important is tooth whitening to our patients?

--A smile has been said to be among man's most important interactive communication skills.

Hattab et al., J Esthet Dent 11:291;1999.

-How does tooth whitening work?

--Peroxide alters conjugated double bonds usually to single bonds and a shorter molecule.

The action alters absorption and reflection of wavelengths on an object making the surface appear different.

Joiner, J of Dent 34:412-419;2006.

--Example of a conjugated double bond molecule, cretin having a dark red color being perceived as colorless upon using peroxide

Thompson et al. Mechanism of Bleaching by Peroxides Part 2. Kinetics of Bleaching of Alizarin and Crocetin by Hydrogen Peroxide at High pH. Journal of the Chemical Society. 89:4035-4043;1993.

-What are the two kinds of stains that develop?

--Extrinsic—Stain, which is found on the outside surface. Whiteners will lighten calculus and the subsurface structure.

--Intrinsic—Stain, which is incorporated into the tooth structure before or after eruption.

-What agent/s lighten teeth?

--Peroxide is active agent. Found in Carbamide Peroxide. Breakdown:

10% CP=3% HP+7% Urea; HP=Oxygen + Water; Urea=Ammonia + Carbon Dioxide

-Can carbamide peroxide improve oral health?

--It affects saliva, plaque, caries and gingival health, improving all of them

Lazarchik, Haywood, JADA 141:639-646;2010

-How is color evaluated in the scientific literature?

--Tooth color should be evaluated both subjectively and objectively.

---Subjectively shade guides are used.

---Objectively a colorimeter or spectrophotometer is used to measure

L*, a*, b* and Delta E.

- Are the methods comparable?
 - If the same subjective and objective instruments are used by the same people they are comparable.

Systems used in Tooth Whitening

- How many systems are there for whitening teeth?
 - There are six major systems, three are At-home systems and three are In-office system.
- What are the advantages and disadvantages of each system?
 - At-home custom tray bleaching
 - Advantages-Lower tooth sensitivity, more effective, less peroxide ingested (with reservoirs)
 - Disadvantages-Not predictable, takes longer.
 - At-home Over-the-counter bleaching
 - Advantages-Less expensive, no doctor visits
 - Disadvantages-Not as effective, higher concentration than recommended
 - There are four major types of over the counter products; Strips, Wraps, Tray-in-Tray and Paint-On
 - In-office bleaching-outside surface (Sometimes called “Power Bleaching”)
 - Conventional
 - Advantages-Rapid tooth whitening; no gel ingested.
 - Disadvantages- Greater sensitivity; rapid reversal of tooth whitening; cannot use it on people who are taking medications that make them sensitive to light; possible “burning” of tissues.
 - Important to isolate with rubber dam or resin dam from the strong concentrations of bleaching agents.
 - In-office outside layer (Sometimes called “Microabrasion”)
 - Advantages- No gel ingested, no tooth sensitivity, accomplished in one setting
 - Disadvantages-Must use rubber dam, demineralizes 8-22 microns, only works on superficial stains
 - In-office bleaching-inside the pulp chamber (Sometimes called “Walking Bleach”)
 - Advantages-No gel ingested, no tooth sensitivity
 - Disadvantages- Need to see patient multiple times, difficult to seal lingual, requires entry into pulp chamber and a barrier placed.
 - Has caused iodopathic root resorption when barrier not placed.

Material Considerations –Concentrations for At-home Use

- What criteria are required for American Dental Association’s Seal that a materials is “Safe” and “Effective”?
 - American Dental Associations (ADA) first guidelines on safety and efficacy of bleaching agents were issued in 1994.
 - J Am Dent Assoc 125:1140-42;1994
 - Efficacy standard was revised in 2006.
 - The following product is accepted as safe and effective by the ADA.
 - Opalescence Whitening Gel **10% CP**
 - http://www.ada.org/ada/seal/adaseal_consumer_shopping.pdf 4/11/11
- What do other major health organizations recommend to dentists regarding tooth whitening agents?
 - Scandinavian Institute of Dental Materials has also recommended “to avoid using concentrations higher than 10% carbamide peroxide”.
 - Dahl & Pallesen, Crit Rev Oral Biol Med 14:229;2003

- European Commission's Scientific Committee on Safety (SCCS)
 - Use of products up to 0.1 HP is safe.
 - Use of products from 0.1-6% HP is safe with approval of dentist.
 - Over-the-counter products should not be available.
 - Clinical examination and first prescription by dentist.
 - Label must have concentration of enclosed whitening agent.
 - Not to be used for those under 18 years of age.

Official J Euro Union, published 29.10.2011
- International Organization for Standardization
 - Concentration: must be on label
 - Peroxide concentration during use life (+10% to -30% variance from label)
 - Surface microhardness (not more than -10% loss)
 - Surface erosion (no more loss than 10 micrometers)

ISO/DIS 28399 published 11.12.201
- Is safety of whitening agents in question?
 - Not if one uses 10% Carbamide peroxide or 3.6% Hydrogen Peroxide

Goldberg, et al., Clin Oral Invest 14:1-10;2010.

Material Considerations --Dental Restoratives

- Is surface hardness and surface finish of dental materials compromised when using tooth whitening agents?
 - Those values are material dependent and minimally affected by bleaching agents.

*Yap et al. Op Dent 27:137-141;2002

*Watanapayungkul et al. Op Dent 28:15;2003

Material Considerations -- Bleaching Agent

- How long is the carbamide peroxide bleaching material active?
 - Determined by ability to recover agent after it is placed.
 - Rapid initial degradation of carbamide peroxide agent and then it slows down.
 - 87% of agent recoverable after 15 seconds in vivo
 - 66% of agent recoverable after 1 hour in vivo
 - 53% of agent recoverable after 2 hours in vivo
 - 31% of agent recoverable after 4 hours in vivo
 - 18% of agent recoverable after 6 hours in vivo
 - 6% of agent recoverable after 10 hours in vivo

Matis et al., J Am Dent Assoc 130:227-235;1999
- How much is used during bleaching?
 - Causes of loss of recoverable agent: bleaching process and remaining in tooth (13%); physical loss of agent (14%), anti-oxidant degradation/increased temperature/product degradation (31%)
 - *Matis, Compendium 24(SI4A):354-362;2003
- Does hydrogen peroxide degrade at the same rate as carbamide peroxide?
 - HP degrades more rapidly than carbamide peroxide
 - 61% of agent recoverable after 5 minutes in vivo
 - 56% of agent recoverable after 10 minutes in vivo
 - 49% of agent recoverable after 20 minutes in vivo
 - 44% of agent recoverable after 30 minutes in vivo
 - 38% of agent recoverable after 45 minutes in vivo
 - 32% of agent recoverable after 60 minutes in vivo

Al-Qunaian et al., Op Dent 28:236-241;2003

- Bleaching is polydirectional
 - Area under brackets is lightened
Jadad, Am J Orthod Dentofacial Orthop 140:e43;2011
 - Tooth under veneer can be lightened
Haywood, Quint Int 30:743-747;1999
- Accuracy of concentration on label
 - Storage for extended time, warm temperature faulty packaging etc can cause products to loose potency.
CRA 21(4):2;1997
 - Product label concerns may be in manufacturing process, or could occur during shipment and storage in the US and other countries. Products tested using method advocated in US Pharmacopia for carbamide peroxide
 - In United States 35 products within 30% of concentration indicated on label
 - In China 13 products tested within 30% of concentration indicated on label
 - In Saudi Arabia 1 of 8 products had greater than 30% difference in concentration than indicated on label
 - In Brazil 3 of 15 products had greater than 30% difference in concentration than indicated on label
Matis et al., Op Dent (Accepted for Publication)
 - Dental schools in different countries should assay tooth whitening products available in their countries and publish it. Method for assay available on website: bamatis.com
- Does a primer accelerate tooth whitening?
 - Does not appear to accelerate process
Da Costa et al. J Esthet Restor Dent 23:97-104;2011

Tooth Concerns

- In dental procedures there are “Benefits” and “Risks”
- Is there loss of adhesion in enamel with resin composites after bleaching?
 - Study in vivo completed recently showed changes in shear bond strength returned to baseline values two weeks after bleaching.
*Metz et al., Op Dent 32(5) 427:2007
 - The reason is “oxygen inhibition” that occurs with Bis-GMA resins.
 - Why not place resin immediately after bleaching?
Cannot bond properly because of oxygen inhibition internally.
Cannot color match because color reversal will occur.
- Is there a loss of enamel microhardness?
 - Review of 55 scientifically valid studies on microhardness recently published.
Attin et al., Den Mat 25:143-157;2009
 - Study in vivo shows no changes in microhardness after bleaching for two weeks.
*Metz et al., Op Dent 32(5) 427:2007
- Are there morphological changes on tooth surface?
 - Effect on enamel micromorphology when 38% HP or 35% CP were used in vivo.
Cadenaro et al., Op Dent 33(2):127-134;2008
 - If product has low pH then micromorphology changes may occur.
Sa et al. Op Dent 38:100-110;2013
- Is there an increase in caries susceptibility?
 - Use of PF will make tooth more resistant to caries.
*Al-Qunaian, Op Dent 30:265;2005

Pulpal Concerns

- Will discomfort occur during tooth whitening?
 - Patient may have one of two different kinds of discomfort: Tooth or Gingival sensitivity.
 - Tray alone causes tooth sensitivity in 20% of patients, add placebo agent and 36% report tooth sensitivity, add active agent instead of placebo and 69% report tooth sensitivity.
Leonard, Whitening Symposium, Loma Linda 2010
- Does peroxide placed on the tooth during cause histological changes to the pulp?
 - Mild histological changes that were observed with 10% CP used overnight are considered to be reversible. No moderate or severe histological changes observed.
Gonzalez-Ochoa, J. Op Dent 29:363-368;2004
- What can be done to reduce soft tissue and tooth sensitivity?
 - Tissue sensitivity
 - To reduce tissue sensitivity, have patient more effectively remove excess bleaching agent that comes out of the tray and have tray trimmed shy of cervical collar of gingiva.
 - Tooth sensitivity
 - Ask patients about sensitivity to cold water when they brush their teeth. If sensitive to cold water, have them start brushing with potassium nitrate containing toothpaste before bleaching.
 - Use of 10% CP for shorter time periods can decrease tooth sensitivity.
Cardoso et al. J Am Dent Assoc 141:1213-1220;2010
 - Sodium Lauryl Sulfate in toothpaste may cause gingival irritation and aphthous ulceration in some patients. Potassium nitrate alone does not cause sensitivity.
 - Do either of the sensitivity reducing agents reduce color change during tooth whitening?
 - There appears to be no difference in capability to reduce color change with use of either of the two most popular sensitivity reducing agents.
Matis et al., Op Dent 32:549;2007

Effectiveness of various concentrations and systems

- Who do we believe on the effectiveness of the various products, the internet?
 - Many opinions on effectiveness. Products claiming unreasonable effectiveness.
- In-office systems vary in use instruction considerably.
 - Survey reported in 2007 that there were 14 products on the market and today there are 18 products on the market.
Dentistry Today.com/Buyers-Guide 29(12);118;2010
- How effective are the In-office systems?
 - In-office bleaching outside tooth surface, Conventional (Power Bleaching)
 - In vivo study of eight In-office bleaching systems: A pilot study (alphabetical order). Manufacturer's were invited to come observe use of their product.
Accelerated In-Office by Life Like ArcBrite by Biotrol
Illumine by Dentsply BriteSmile by BriteSmile
Niveous by Shofu PolaOffice by SDI Industries
One Hour Smile by Den-Mat Zoom! by Discus Dental
*Matis et al., Op Dent 28:324;2007
 - Light use did not improve the effectiveness of the In-office conventional system
Effectiveness evaluated with and without use of light.
Opalescence Xtra Boost PolaOffice Rembrandt Lighten Plus
LumaArch Niveous LaserSmile Zoom!
CRA Newsletter 27(3):3;2003

- Light does not enhance tooth bleaching and may pose a health risk especially those with ultraviolet light.
Bruzell, et al. Photochem and Photobio Sci., 8:377;2009
- Intrapulpal temperature rise may have detrimental effect on the pulp?
Zach et al., O Surg, O Med, O Path 19:515-530;1965
- How much temperature rise occurs on gel and intrapulpal area during light enhanced bleaching?
Baik et al. J Esthet Restor Dent 13:370;2001
- ADA accepted At-home agent was more effective than an ADA accepted In-office conventional agent
*Zekonis et al., Op Dent 28:114-121;2003
- Patients accept At-home more than In-office
CRA Newsletter 29:2;2005
- Is there a need for In-office bleaching?
J Esth Rest Dent 16:87;2004
- How much difference in tooth whitening with 1-45 min or 3-15 min application?
Reis et al. Op Dent 36:590-596;2011
- At-home systems will boost in-office systems
*Matis et al. Op Dent 34;142-149;2009
- In-office bleaching outside tooth surface (Microabrasion)
 - Microabrasion is effective on superficial enamel defects
Benbachiretal et al., Quint Int 38;811-815;2007
- In office bleaching inside tooth chamber (Walking Bleach)
 - Sodium perborate can be mixed with water as well as peroxide with equal effectiveness.
de Souza-Zaroni et al., Oral Surg, Oral Med, Oral Path, Radoil, Endod 107:e43-e47;2009
- How effective are the At-home systems used with a custom tray?
 - All studies had at least **24 subjects**, bleached for **14 days** and **used reservoirs** in trays. Maxillary anterior teeth evaluated for color **objectively** and **subjectively**.
 - Not everyone lightened as they had hoped as evidenced by evaluation of clinical photographs. Reversal of color came to a plateau in four to six weeks postbleaching. Efficacy of 10% CP used for two weeks shows 17% large change, 48% moderate, 21% slight and 14% none after six months.
Matis et al., Quint Int 29:555;1998
- There are three other half-mouth design studies which taught us some important concepts.
 - 10% CP and 15% CP, overnight. 15% was no different than 10% at the end of one month
Matis et al., Quint Int 31:303-310;2000
 - 15% CP and 5.5% HP, ½ hour 2X daily showed equal concentrations produced equal results.
Panich, Masters Thesis, IUSD, 1999
 - 20% CP and 7.5% HP, 1 hour 2X daily showed 20% twice a day was no better than 10% overnight.
Mokhlis et al., J Am Dent Assoc 131:1269-1277;2000
- We can now compare the In-office with three studies using 10% CP overnight in trays with reservoirs. 10% was twice as effective both subjectively and objectively than In-office products.

- Do we need reservoirs in our trays?
 - Teeth in the side of the trays with reservoirs were statistically lighter, but not clinically lighter than teeth in side of the trays without reservoirs. More gel is ingested by patients using trays without reservoirs.
 - Matis et al., Op Dent 27:5;2002
- How effective are the Over-the-counter systems?
 - There are two kinds of Over-the-counter products, whitening toothpaste and whitening gels.
 - Whitening toothpastes found over-the-counter
 - Toothpaste will not lighten a tooth internally unless it has peroxide in it.
 - A toothpaste containing peroxide will keep teeth lighter longer.
 - Whitening toothpaste decreases reversal of color that happens after vital tooth bleaching.
 - Matis, Indiana Dent J 77(3):27-32;1998
 - Whitening gels found over-the-counter
 - What is their effectiveness in bleaching? For six Vita tab changes; Strips (30 min)=31 cycles At-home (8 hours)=7 cycles, In-office (15 min)= 3 cycles.
 - Auschill et al., Op Dent 30:156-163;2005
- Is there one comparison of all the systems effectiveness?
 - Nine studies with 26 products with both subjective and objective evaluations
 - At-home nighttime in tray with reservoir is most effective system
 - At-home daytime in tray is next most effective system
 - Over-the-counter is next most effective system
 - In-office systems is the least effective system
 - *Matis et al., Op Dent 34:230-235;2009

Odds and Ends

- How long do patients use agent?
 - When cuspids become as light as central and lateral incisors.
- Do I deliver both trays at the same time?
 - Deliver maxillary tray first so patients can see the amount of bleaching that has occurred.
- Rebleaching, how often should it be done?
 - When needed, probably every one to three years.

- Does rebleaching take as long as initial bleaching?
 - No it is much faster, one day of rebleaching is usually required for every 5-7 days of initial bleaching.
- Can we guarantee lightness with bleaching?
 - No, but I tell patients I will apply the money it costs to bleach on a discount for veneers or crowns within three months if they are not pleased with the results.
- How long does tooth whitening last?
 - 42% were satisfied after 10 years post bleaching
 - Leonard et al., J Esthet Rest Dent 15:142-152;2003
- How old should patients be before bleaching?
 - Should not lighten teeth while patient is in mixed dentition.
 - Tooth whitening for individual teeth has a different policy.
 - Ped Dent 30(7 Sup):61-63;2008

- Can a patient over bleach—if so, when do you stop bleaching?
 - We cannot conduct studies to determine this as the first principle of research is “Do no harm”. Therefore when cuspids become as light as the central and lateral incisors I tell patients it is time to stop bleaching.
- Will bleach penetrate a resin?
 - It will go around and underneath a resin. Before replacing veneers due to darkened color, bleach from inside.
 - Haywood, et al. Quint Int 30:743;1999
- Is the use of hydrogen peroxide or carbamide peroxide safe?
 - “All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.”
 - Paracelsus (1493-1541)
 - Use of peroxide does not cause oral cancer.
 - Munro et al., J Esthet Rest Dent 18:119;2006.
 - Body produces about 6.5 g of peroxide daily in the liver.
 - Li, Y. Dent Clin N Am 55:255-263-2011
- Are there any contraindications for tooth whitening?
 - Patients with resin allergies, peroxide allergies and pregnant or lactating patients.
- Are there other excellent sources of information on tooth whitening?
 - Excellent article entitled “Biological Properties of Peroxide-containing Tooth Whiteners”.
 - Li, Food and Chemical Toxicity 34:887-904;1996
 - Excellent book on bleaching entitled “Bleaching Techniques in Restorative Dentistry” by Linda Greenwell, published by Martin Dunitz, London, England.
 - Matis, Op Dent 27:103;2002 Book reviewed
 - Book entitled “Tooth Whitening: Indications and Outcomes of Nightguard Vital Bleaching”
 - Van Haywood, Published by Quintessence International

Clinical Cases

4 year old who fell down, traumatizing deciduous central incisors, which were bleached for a total of 47 hours.

Brantly et al. Ped Dent 23:514;2001

83 year old male who bleached for 6 weeks with one-month post-bleaching

19-year-old male, endodontically treated N 11, placed glass ionomer plug, bleached internally and externally for 2 weeks each. Followed for 2 months post-bleaching.

36-year-old female, trauma caused discoloration of tooth N 11, no periapical pathology, bleached 6 weeks. Followed for 4 months post-bleaching

28-year-old male, semi-professional football player/student, canal in tooth N 21 calcified and tooth discolored, bleached for 5 weeks, rebleached after 9 months.

62-year-old female bleached mandibular teeth 6 weeks. Followed for 2 months post-bleaching.

Lightened stained craze line on N 21 on 66-year-old female. Followed for 4 months post-bleaching. Cervical dentin does not usually lighten much with bleaching.

Hypocalcified area was bleached for 14 days, white spot lightened rapidly then returned to original color after cessation of bleaching.

Unhappy person who was dissatisfied with vital bleaching and decided on veneers.

Fluoride stain removal using bleaching on a 28 year old.

Tetracycline should not be used in patients before 8 years of age, minocycline can stain adults teeth and should be used only where no other drug is as effective (ie Rocky Mountain Spotted Fever)

Bowles, Bokmeyer, J Esthet Dent 9:30-34;1997

Tetracycline stain removal in a study accomplished in the Peoples Republic of China

--Not all tetracycline staining can be bleached, Cervical area stain removal most challenging to remove,

*Matis et al., Op Dent 31(6):643-651;2006

Never promise results but help patients understand the possibilities!

* Articles are available on Dr Matis' web site- www.bamatis.com

Other questions patients often ask and their answers

How long do I use the product?

Usually from 2-4 weeks. (On some teeth that are yellow due to aging, I have used the agents for 2 months. Use it as long as teeth continue to lighten. Dr. Haywood has used agents for 12 months on tetracycline stained teeth.)

When will I notice some effect?

In about three days.

What if I cannot wear the tray all night?

Wearing the tray is usually not a problem. The tray is like a contact lens; it stays in place with the gel. Some people will salivate more the first couple of nights. If you find you cannot sleep with it through the night we will have you wear it in the morning or evening for a couple of hours. That way will just take a little longer .

What happens if I miss a day?

No problem, just wear it the following evening.

Can I rebleach?

Yes, use the same tray. The product is good for 18 months in the refrigerator.

I am pregnant, can I use At-Home whitening agents?

We recommend you not bleach while you are pregnant or use bleaching agent until you have completed nursing. (There is no evidence it would harm the newborn, but no studies have been conducted to determine if it would harm the offspring. This is an elective procedure so it is better to wait.)

Is it true that laser bleaching is more effective than at-home bleaching?

No. (The American Dental Association has stated that laser bleaching is not more effective than at-home bleaching.)

Will it damage my crowns or fillings?

No, it will not damage fillings or crowns. It will not lighten them either. It will discolor some temporary filling materials.

There is an excellent article on my web site by Dr Haywood entitled “Frequently Asked Questions about Bleaching”, which was published in Compendium 24(4A):324-338;2004.